Ontario Hydro

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UTILIZATION SECTION PROGRAMS 1987

Report No 86-354-K

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An overview is given of the major projects planned for the Utilization Section 1987. For each project, the objectives, some detail of the activities and the deliverables are described.

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To: Dr. D. Mills
Director of Research

UTILIZATION SECTION PROGRAMS 1987

Introduction to Catalog

This catalog is intended to provide an overview of the major work programs in the Utilization Section of the Research Division. It is divided into sections on industrial and residential/commercial. One-page descriptions are given of the objectives, methods, and deliverables of each program.

Enquiries should be directed to the project engineer whose name and phone number are listed on each page. Detailed information (ie budget, completion date, etc) on each of the approximately fifty projects making up the major programs may be obtained from the project record form system at the Research Division.

In addition, the catalog contains an organization chart of the Utilization Section with phone numbers and describes the responsibilities of each unit.

As is the nature of research, our programs are evolving over time. We welcome your interest and invite your input.

Approved:

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Submitted:

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JMB:ra

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Functions of the Utilization Section

The Utilization Section provides technological innovation and support to improve customer benefits and power system utilization through developments in end-use technology and alternative energy systems.

Thermal Systems Unit

This unit carries out the functions of the Utilization Section with respect to space heating systems, controls and wiring etc. This includes the development of advanced heat pump systems (northern, ground, water etc).

Energy Management Unit

This unit carries out the functions of the Utilization Section with respect to water heating, ventilation, appliances, building thermal performance and strategic conservation etc.

Process Applications Unit

This unit carries out the functions of the Utilization Section with respect to industrial applications and development of electrotechnologies such as heat pumps, microwaves, radio frequency etc.

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Index to Work Program

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- Mechanical Vapour Recompression
- Non-Traditional Heat Pumps

Residential/Commercial

- Ground-Source Heat Pumps
- Air-Source Heat Pumps
- Bivalent Heat Pumps
- Novel Electric Heating Systems
- Water Heating
- Ventilation, Indoor Air Quality, Heat Recovery
- Building Envelope

TOPIC: PRODUCT PROCESSING WITH DIELECTRIC (MICROWAVE AND RADIO-FREQUENCY) AND INFRA-RED HEATING

SECTOR: Industrial

OBJECTIVES:

1. To demonstrate industrial applications of dielectric (microwave and radio-frequency) and infra-red heating in support of Marketing staff and potential Ontario users.

2. To develop novel applications for dielectric and infra-red heating.

DETAIL:

The following approach will be used to meet the objectives:

1. Product Assessment/Technology Demonstration - Laboratory and process equipment will be used to demonstrate the use of dielectric and infra-red heating for a wide variety of industrial process heating applications including drying, curing, tempering, bonding, cooking, sintering, etc. Preliminary feasibility assessments (in cooperation with the regions) will provide the technical and economic factors required to help Ontario industry select and optimize the correct technology for their particular process.

2. Process/Technology Development - Novel applications of dielectric and infra-red heating will be investigated either alone or in combination with conventional heating equipment. The focus will center on the processing of new materials (ie, ceramics, polymers, composites, etc) and may include changes to conventional processes and product composition.

DELIVERABLES:

1. Demonstrations of dielectric and infra-red heating (laboratory and in-plant) will be conducted to provide potential users with an understanding of the electrotechnologies and their effect on product properties and plant processes. These studies will include assistance in the selection, optimization and economics of process equipment for specific industrial processes.

2. Cooperative research projects with Ontario industry will continue to develop novel applications for dielectric and infra-red heating with particular emphasis on high-value added products such as advanced ceramics, polymers and food.

3. Memos and reports documenting the above deliverables will be published.

UNIT: Process Applications

CONTACTS: S.J.(Steve) Oda (122+6722)
B.G.(Brian) Woods (122+6978)

TOPIC: INCORPORATION OF RADIANT TECHNOLOGIES INTO AN AUTOMATED ENVIRONMENT

SECTOR: Industrial

OBJECTIVES:

1. To develop novel applications for robots and radiant energy which will allow more efficient and selective heating of large objects.
2. To develop laboratory facilities to demonstrate the coordination of electrotechnologies and automation technologies.
3. To evaluate production potential when specific robots are applied to a process.

DETAIL:

The objectives will be achieved through the following approach:

1. Development of a lab facility for retrofitting applicators of radiant energy to a robot manipulator and coordinating the control of the robot and application of the radiant energy.
2. Development of a computer simulation of the robot kinematics to factor the joint position and speed limits of the robot into the production capacity calculation.

DELIVERABLES:

1. Laboratory facility for demonstrating the coordination of electrotechnologies in an automated environment.
2. Computer simulation capability for evaluating the production potential when certain robots are used.
3. Reports and memos documenting the above deliverables will be issued.

UNIT: Process Applications

CONTACTS: S.J. (Steve) Oda, (122+6722)
B.G. (Brian) Woods, (122+6978)

TOPIC: PRODUCT DRYING BY DEHUMIDIFICATION

SECTOR: Industrial

OBJECTIVES:

1. To develop and demonstrate product drying concepts and systems employing heat pump dehumidification techniques aimed at improving the economics of drying compared to fossil heated systems.

2. To develop drying application analysis tools to aid in the technical and economic assessment of potential applications.

DETAIL:

The objectives will be achieved through the execution of an integrated approach that includes:

1. Product Assessment - Test facilities, used to evaluate product drying characteristics, will be upgraded to provide more rapid and accurate assessments. Test and analysis procedures will be streamlined to allow fast turn-around feasibility assessment of customer applications.

2. Modeling - Computer based analysis tools will continue to be developed to aid in the assessment of opportunities for dehumidification drying and the optimization of dehumidifier performance. Packaging of assessment tools for transfer to client groups will be initiated.

3. Dehumidification Dryer - The test facility will be used to perform pilot-scale product drying demonstrations. This will allow potential users to participate in trials of new dehumidifier applications and provide verification of predicted drying performance.

DELIVERABLES:

1. Improved product assessment facilities (ie test chambers and analysis procedures) to efficiently determine the suitability of candidate processes for dehumidification drying.

2. Application models to assess the feasibility of replacement of fossil heated product dryers with heat pump dehumidification systems.

3. Feasibility assessments of customer applications will be conducted in the test facilities to provide potential users with an understanding of dehumidification drying and the effect of this electrotechnology on plant processes. These studies will include assistance in the selection, optimization and economics of drying equipment for specific industrial processes.

4. Reports and memos documenting the above deliverables will be issued.

UNIT: Process Applications

CONTACTS: J.T. (Terry) Strack (122+6723)
D.J. (Doug) Stevens (122+6266)
A.T. (Andrew) Chow (122+6266)

TOPIC: HEAT PUMP HEAT RECOVERY

SECTOR: Industrial

OBJECTIVES:

1. To demonstrate the feasibility of operating high temperature compression heat pumps for industrial applications.

2. To identify areas in industry where heat pumps, that produce steam or hot water at temperatures approaching 120°C could be applied successfully.

DETAIL:

The objectives will be achieved by testing a standard industrial heat pump and then designing, installing and testing a higher temperature compression heat pump. A review of literature and discussions with experts and equipment manufacturers in the industry will be conducted to identify promising applications.

The work has been structured into a four-phase program comprised of the following:

1. Design and fabrication a test-loop to evaluate water-to-water compression heat pumps.

2. Test an existing water-to-water compression heat pump (Templifier) at Research. Experience will be gained while demonstrating the viability of this existing technology to industry.

3. Identify research needs for high temperature heat pumps (HTHP). This will include an assessment of candidate fluids for HTHP, and development of a tendering specification for a small HTHP.

4. Install and test a HTHP to assess performance under a variety of operating conditions.

DELIVERABLES:

1. The following reports will be prepared:

   Candidate Working Fluids for Use in a High Temperature Heat Pump
   Design of a Heat Pump Test Loop
   Performance of a "Templifier" Heat Pump
   Applications for High Temperature Heat Pumps in Industry
   Performance of a High Temperature Heat Pump

2. Access to an operating industrial heat pump. This can be used as a showcase to assist in the marketing of industrial heat pumps to Ontario industry.

UNIT: Process Applications

CONTACTS: J.T.(Terry) Strack (122+6723)
C.E.(Carl) Keyes (122+6506)

TOPIC: MECHANICAL VAPOUR RECOMPRESSION

SECTOR: Industrial

OBJECTIVE:

To provide technical support for corporate initiatives directed at promoting mechanial vapour recompression (MVR) technology to Ontario industry.

DETAIL:

In cooperation with Marketing and the Regions, current industrial applications of MVR will be identified. Further technical information on the performance of the technology will be developed through discussions with equipment manufacturers and by monitoring the performance of a typical installation. Equipment sizing procedures for new installations will be developed and distributed to marketing personnel. Potential field problems, related to electrical component reliability, will be investigated.

DELIVERABLES:

A status report on applications for MVR technology in industry as well as a condensed version in the "REDIFAX" format will be produced. The performance of a typical MVR installation will be measured. This data will be suitable for inclusion in a "case-study" report. Technical support will be provided to size equipment for new applications and to improve the performance of existing installations.

UNIT: Process Applications

CONTACT: J.T. (Terry) Strack (122+6723)
C.E. (Carl) Keyes (122+6506)

TOPIC: NON-TRADITIONAL HEAT PUMPS

SECTOR: Industrial

OBJECTIVE:

To keep abreast of advances in industrial heat pump technologies.

DETAIL:

Perform a state-of-the-art study of the various heat pump techniques (both electric and non-electric) that are currently in use or under development. Assess the potential of electric-driven vapour compression heat pumps in relation to other heat pumping technologies.

DELIVERABLES:

A status report on non-traditional heat pumping techniques with recommendations for future course of action.

UNIT: Process Applications

CONTACT: C.E. (Carl) Keyes (122+6506)

TOPIC: GROUND-SOURCE HEAT PUMPS (GSHPs)

SECTOR: Residential and Commercial

OBJECTIVES:

Investigate the demand management potential of ground-source and water-source heat pumps. Assist Market Services and Marketing Operations Divisions in their assessment of avoided peak demand with GSHPs. Continue to research lower-cost installation techniques for GSHPs.

DETAIL:

1. Provide technical planning and monitoring assistance to the Head Office groups conducting the Bayview Hills GSHP field trial. This assistance will include specifying the number and type of monitoring packages needed, designing and building one prototype package, and spot checking the installation and operation of selected systems.

2. Investigate, under laboratory conditions, the parallel connection of more than one heat pump evaporator. Evaluate the practicality of such arrangements for reducing the installed costs of GSHP systems and increasing the versatility of heat pumps for heat recovery purposes.

3. Establish a field test location for the evaluation of novel GSHP ground coil designs, such as those suggested by work of the NRC. Monitor the performance of such systems under real heating duty conditions and estimate the cost reduction potential of the designs.

4. Negotiate a field testing arrangement with the operators of the Queen's Quay lake source commercial heat pump (unique in North America). The documentation of the operation of this system will provide an example that could be followed at any water-front development.

DELIVERABLES:

1. Consultation and advice to the Bayview Hills GSHP project team at Head Office. (Design of the monitoring system, production of one monitoring package, spot check reports on the monitoring equipment performance.)

2. A Research Report on the feasibility and merits of using more than one evaporator to recover heat from sources at different temperatures.

3. A performance and economic evaluation of spiral copper ground coils for GSHPs.

4. Test results from an operating commercial building lake-source heat pump will be obtained and published if an agreement with Terminal Building owners can be reached.

UNIT: Thermal Systems

CONTACT: D.J. (Dave) Young (122+6815)
F.J. (Frank) Lenarduzzi (122+6506)

TOPIC: AIR-SOURCE HEAT PUMPS

SECTOR: Residential

OBJECTIVES:

Improve the thermodynamics and efficiency of the heat pump cycle. Investigate the reliability of heat pumps under lab and field conditions. Evaluate the in-situ performance of state-of-the-art heat pump products that are about to impact on the Ontario marketplace.

DETAIL:

1. Undertake the second phase of a major study of heat pump reliability that will allow homeowners to make an informed choice of heating systems and heat pump brands.

   a) Continue the development of an accelerated Reliability Test for heat pumps.

   b) Direct, through CEA, the customer survey update of heat pump maintenance records from across Canada.

2. Carry out a field evaluation of the Trane high performance heat pump. This machine promises higher levels of performance than currently available products in the Ontario market. Later phases of this project will evaluate variable-speed compressor technology as it is introduced to the marketplace.

3. Investigate mechanical defrosting systems for heat pumps. Such systems may enable improvements to be made to the efficiency and reliability of existing air source heat pump systems.

4. Develop a non-intrusive COP meter. This would easily and quickly verify the correct operating parameters of a heat pump system and lead to increased customer satisfaction and decreased maintenance costs.

5. Merge the stepper-motor expansion valve and the cold climate heat pump technology.

6. Continue field monitoring of the Ontario Hydro/CEA/KeepRite heat pumps.

7. Conduct lab and/or field evaluation of a single-package European heat pump unit which may have certain reliability advantages because of its factory-sealed design.

8. Maintain the Ontario Hydro Environmental Test Facility for Heat Pumps, conduct tests of novel heat pump hardware, and inform Marketing about the full range of heat pump technology available to the customers of Ontario Hydro.

9. Represent Ontario Hydro on the CEA Technical Committee for Heat Pumps (C273.3). Participate in the Ontario Hydro/SCOPEP effort to draft a new Canadian standard that includes noise-level testing.

10. Maintain international contact with other heat pump research organizations such as ASHRAE, EPRI, ORNL, the Heat Pump Coordinating Committee (IEA) and the International Power Utility Heat Pump Committee.

DELIVERABLES:

1. Reliability information will be obtained on heat pumps, and a recommendation on the feasibility of a Reliability Test Standard will be made.
2. Development of a Canadian Heat Pump Standard which will include minimum performance requirements in response to consumer concerns.
3. Recommendations on the use and applicability of stepper-motor expansion valves in heat pumps.
4. Recommendations on the use of novel systems such as mechanical defrosting.
5. Demonstration of a functioning COP meter.
6. A Research Report on the in-situ performance of a state-of-the-art production heat pump (Trane) will permit benchmark comparisons with past and future equipment.
7. A Research/CEA Report summarizing the field performance of the Ontario Hydro/ CEA/KeepRite heat pumps.
8. A Research Report analyzing advantages of a single-package European Heat Pumps.

UNIT: Thermal Systems

CONTACT D.J. (Dave) Young (122+6815)
F.G. (Frank) Pellini (122+6886)
D.F. (Dave) Cuthbert (122+6270)
S. (Steve) Yap (122+6270)

TOPIC: BIVALENT HEAT PUMPS

SECTOR: Residential and Commercial

OBJECTIVES:

Improve the thermodynamics and efficiency of current bivalent heat pumps. Investigate whether corrosion can occur under field conditions. Evaluate the in-situ performance of state-of-the-art bivalent heat pump products that are about to impact on the Ontario marketplace. Investigate the demand management potential of bivalent heat pumps.

DETAIL:

1. Continue field monitoring of a Kool-Fire unit with modifications made to its refrigerant circuitry to improve the thermodynamic cycle.

2. Carry out a field trial of the next generation Kool-fire heat pump. Design changes made by the manufacturer could prove significant in improving performance.

3. Demonstrate an improved, manually-actuated reversing valve for the Kool-Fire heat pump. Such a valve could reduce operating losses associated with heat and mass flow leakages from the high to the low side of conventional reversing valves. If practical, apply the valve to a field installation.

4. Collaborate with EPRI in an investigation of long-term corrosion potential of the Kool-Fire heat pump.

5. Investigate a total energy system incorporating the Kool-Fire principle. Such a system would supply both heating and domestic hot water requirements with excellent demand management possibilities.

DELIVERABLES:

1. The following reports will be prepared:

   a. The performance of the latest generation of Kool-Fire heat pumps.

   b. Recommendations on the modification of reversing valves operated on a seasonal basis.

   c. Demonstration of a total energy system incorporating a Kool-Fire heat pump.

   d. Analysis of the long-term corrosion potential of the Kool-Fire heat pump.

2. Assistance will be provided to Head Office groups involved with demand management issues and the wider commercialization of bivalent technology.

3. Advice will be provided to the Ministry of Industry, Trade, and Technology and to the manufacturer in their quest to increase the commercial viability of the Kool-Fire heat pump concept.

UNIT: Thermal Systems

CONTACT: D.J. (Dave) Young (122+6815)
D.F. (Dave) Cuthbert (122+6270)

TOPIC: NOVEL ELECTRIC HEATING SYSTEMS

SECTOR: Residential and Commercial

OBJECTIVES:

Improve the performance, cost effectiveness, and/or the system load factor of existing and new electric heating systems.

DETAIL:

1. Investigate and demonstrate innovative electric heating hardware and controls.
2. Investigate new applications of existing electrical products to maximize the benefits to the consumer.
3. Conduct measurements, at the request of Head Office clients, on the performance of dual fuel heating systems or the wiring systems associated therewith.

DELIVERABLES:

1. A working prototype of a second generation wireless infra-red linked thermostat will be produced and a report issued.
2. Demonstration and report on an inexpensive add-on proportional control for central electric furnaces (developed at OHRD).
3. Reports and memos summarizing results of work requested by Head Office clients.

UNIT: Thermal Systems

CONTACT: F.G. (Frank) Pellini (122+6886)

TOPIC: WATER HEATING

SECTOR: Residential & Commercial

OBJECTIVES:

1. Develop higher performance electric water heaters for residential and commercial use. Assess operating characteristics and costs of new water heating technologies. Document the performance of electric versus fuel-fired water heating systems. Identify areas where new water heating technologies could be applied successfully in Ontario.

DETAIL:

1. Monitor the market place for innovative energy-efficient water heaters (eg, plastic water heater) and perform laboratory and field evaluation tests as required.

2. Assess technical innovations, energy savings devices and new installation techniques such as; improved thermal insulation and desuperheaters to improve the thermal performance of existing water heaters.

3. Assist in developing new water heating technologies such as; heat pump water heaters, exhaust air and waste water heat recovery systems and others.

4. Assist, through CEA, in the feasibility assessment and prototype development of such combination appliances as outdoor/indoor heat pump/water heater, refrigerator/water heater, refrigerator/ventilator/water heater/clothes dryer, and integrated mechanical system (which includes ice storage and grey-water heat recovery).

5. Continue the monitoring of a commercially-sized heat pump water heater installed in a restaurant. Assess system operating capabilities, energy savings and load management alternatives.

6. Compare performance and operating costs of electric versus natural gas water heating in apartment buildings. Develop "typical" hot water and energy use patterns. Assess the energy and demand effects of the Pro-Temp 8000 water heater controller which learns the pattern of hot water usage in a building and controls the energy supply to meet the learned requirements.

7. Represent Ontario Hydro on CSA and ASHRAE technical committees on Service Water Heating.

8. Maintain international contact with other research organizations such as; ASHRAE, EPRI, LBL, NBS.

. **DELIVERABLES:**

1. Recommendations for optimization of thermal performance of existing water heating systems.

2. A Research Report summarizing the field performance of a commerically-sized heat pump water heater in a restaurant including results on delivery capability, energy and demand performance and competitiveness versus fuel-fired water heating systems.

3. List of opportunities for the use of new water heating technologies in residential and commercial sectors. Identification of new roles, including load management and strategic conservation alternatives.

4. A Research Report summarizing the results of one year of field measurements on the water heating installations in five apartment buildings. Hot water and energy use patterns will be developed to assist in future design of such systems. Operating characteristics and costs of natural gas versus electric water heating will be examined.

5. Technical papers on the use of heat pump water heaters in commercial applications and the newly developed hot water and energy use patterns will be presented at technical conferences.

6. Advice and assistance to Marketing clients as required.

UNIT: Energy Management

CONTACT: M. (Maier) Perlman (122+6196)
N. (Neil) Milligan (122+6286)
M. (Mario) Chiarelli (122+6258)
W.R. (Bill) Jones 122+6253)

TOPIC: VENTILATION, INDOOR AIR QUALITY, HEAT RECOVERY

SECTOR: Residential and Commercial

OBJECTIVES:

Assess the performance of innovative heating, ventilating and air conditioning (HVAC) equipment and the effect on the power system. Improve conditions for the health and comfort of residential customers. Develop diagnostic checklists to deal with indoor air quality complaints in the commercial sector.

DETAILS:

1. Assess the performance (in a simulated-residential laboratory test set-up: air flows, energy outputs, cross-contamination via tracer gas, etc) and ease of installation and servicing of the Peach-Super, a multi-source, multi-function (space heating and cooling, water heating and ventilating) Canadian-developed all-electric appliance which can be used in the residential and small commercial sectors. Investigate its potential in the Ontario market and power system. Possibly field test this appliance.

2. Complete development of a unique Canadian full-scale ventilation test room. By measuring temperatures, air flows and tracer gas dispersions, assess the ventilation effectiveness and comfort ramifications of existing and new methods of fresh air supply and distribution in houses, especially low-energy, airtight models.

3. Contribute to the development of the CSA residential ventilation standard and the resulting HRAI residential air system design manual. Only by training the trades with the use of this manual can the provision of mechanical ventilation in new housing be safely, healthfully and comfortably implemented (via the Ontario Building Code).

4. Begin development of a checklist to assess indoor air quality complaints in commercial (especially office) buildings, possibly using building KR as a test bed, and with outside expertise concerning health effects, chemical and biological assays and ventilation and building envelope testing. Connect to the rapidly evolving research in this area through ASHRAE, CEA IAQ Task Force, NRC, EPRI, HWC, NIOSH, etc.

DELIVERABLES:

1. A Research Report on the technical aspects and market potential of the Peach-Super, with a recommendation concerning a field trial.

2. A Research Report giving a preliminary assessment of the appropriateness (for health and comfort) of various residential air system designs.

3. Preliminary CSA Residential Ventilation Requirements Standard and HRAI Residential Air System Design Manual, allowing implementation of the requirement for mechanical ventilation in all new housing in the Ontario Building Code.

4. A Research Report containing a preliminary IAQ assessment checklist for office buildings, and the results from Building KR.

UNIT: Energy Management

CONTACT: W.R. (Bill) Jones (122+6253)
M. (Maier) Perlman (122+6196)
N. (Neil) Milligan (122+6286)

TOPIC: BUILDING ENVELOPE

SECTOR: Residential and Commercial

OBJECTIVES:

Increase the thermal integrity of houses by assessing new window materials. Add window control to energy management systems in the commercial sector by assessing novel fenestration control films. Further elucidate the effect of thermal envelope upgrading on the demand and energy characteristics of existing housing. Develop specifications for the ultimate new house.

DETAILS:

1. Assess new window technologies in the Ontario context by:

   a) obtaining samples of aerogel material, infrared-reflective film, electrochromic film, etc from contact with Lawrence Berkeley Labs, Simon Fraser University, Ontario Research Foundation, etc, or setting up production facilities if necessary; and

   b) performing applications testing on these items in a new fenestration laboratory.

2. Study the place of new energy management/information systems in the residential (eg Smart House) and commercial (eg integration of electrochromic film technology into EMS) sectors in providing control over energy usage and demand requirements.

3. Analyse the results of the second year of monitoring after the thermal upgradings in the 13 test houses and compare the results with the first year to show any changes in the energy and demand effects of the retrofits. Ensure that those responsible for any Strategic Conservation demonstrations are cognizant of these results and their implications.

4. Develop, possibly in conjunction with the Canadian Home Builders' Association, specifications for the 'house of the future': healthful for the occupants, structurally sound, inexpensive and with a good load shape. Participate in the actualization of these concepts in CHBA's demonstration house and help to monitor its performance if requested.

5. Continue to respond to Marketing enquiries in this subject area, including such recently-completed topics as load calculations, energy determinations, chimney integrity, etc.

6. Maintain technical currency in building envelope, building science and whole building system research and development through contact with and committee work for such organizations and associations as ASHRAE, CHBA, LBL, ORF, SRC, CCRL, CEA, various Canadian university centres, HRAI, OEL, various Canadian manufacturing and consulting firms, etc.

DELIVERABLES:

1. Research Reports detailing the preliminary technical characterization of improved windows and new technologies, including assessment of the potential of new fenestration technologies in the Ontario context, together with recommendations for further research and development, demonstrations, manufacturing support, etc.

2. Research Reports covering the preliminary assessment of new and expanded energy management systems in the residential and commercial sectors.

3. An Addendum to the Thermal Envelope Upgrading Report qualifying the strategic conservation potential in the housing retrofit area in light of the persistence of the effects, and making recommendations concerning demonstration projects.

4. An ultimate house demonstration incorporating aspects useful to electric utilities and their customers.

5. Response to any requests received from Marketing clients.

UNIT: Energy Management

CONTACT: M. (Maier) Perlman (122+6196)
W.R. (Bill) Jones (122+6253)
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